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RECENTLY PUBLISHED RESEARCH OF THE LENINGRAD POLYTECHNIC INSTITUTE IMENI M. I. KALININ

"Motion of Positive Ions in Gases in an Electric Field," L. A. Sena, Leningrad Polytech Inst imeni M. I. Kalinin

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(1) The assumption of a nearly Maxwellian distribution of velocities, with the field-parallel component small is compared with the mean velocity, proved to be valid for electrons even in strong electric fields, but does not hold for positive gaseous ions. This is due to equality of the orders of magnitude of the size of ions and atoms, but mainly to the predominant role played by the transfer of electrical charge between ions and atoms. With the simplifying assumption that this charge exchange process is the only significant interaction, that its probability is independent of the velocity of the ion, and that thermal velocities of neutral atoms are negligible, and ion is seen to conserve its velocity after neutralization through exchange of charge with an atom, and the latter new ion to start its motion along the field with zero kinetic energy. This representation leads to an expression for the mean velocity of ions parallel to the field, $\bar{v} = 4.5 \times 10^5 (U/A^{1/2}) (E/P)^{1/2}$ where U = ionization potential of the atom, A its atomic weight, E = field intensity, P = pressure reduced to 0°. The derivation involves the approximate expression for the effective cross section for charge transfer $Q = 1.88 \times 10^{-8}/v^2$, strictly valid at high velocities; at low velocities, Q cannot be considered constant but must increase with $\bar{v}$; also, direct elastic exchange of energy on collision becomes significant. As these two effects

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tend to counteract each other, compensation results and the above-given expression for $\bar{v}$ becomes applicable not only to strong fields, but also in the case of relatively small E/P. This checks with the proportionality between $\bar{v}$ and $(E/P)^{1/2}$ observed by K. Kingdon and E. Lawton, for E/P from 20 to 6,000 v/cm/mm HG. The experimental value of $\bar{v} = 10^5$ cm/sec for E/P = 1,000 checks with the calculated $\bar{v} = 1.05 \times 10^5$. The formula consequently can be expected to hold also for fields of the order of those of the plasma, 100 v/cm/mm Hg. (2) Angular distribution of the velocities is shown to be sharply anisotropic, unrelated to any Maxwellian distribution and to the very concept of temperature.

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